Electroneurography in the acute stage of facial palsy as a predictive factor for the development of facial synkinesis sequela.

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Abstract

Objective

We investigated whether the value of ENoG is a predictive factor for the development of facial synkinesis in patients with facial palsy.

Methods

The degree of oral-ocular synkinesis was evaluated quantitatively by an asymmetry of the interpalpebral space width during the mouth movement (% eye opening). Twenty healthy volunteers without a history of facial palsy (12 men and 8 women; 25-65 years old; mean age: 42.3 ± 9.7 years) were included in the study to examine the normal range of % eye opening. Fifty-one patients with facial palsy including 38 with Bell palsy and 15 with herpes zoster oticus (28 men and 25 women; 11-86 years old; mean age: 54 ± 19 years) were enrolled to examine the relationship between the ENoG value 10-14 days after the onset of facial palsy, and the % eye opening 12 months later. Receiver operating characteristic (ROC) curve for the ENoG value was then used to decide the optimum cut-off value as a predictor of the development of oral-ocular synkinesis.

Results

We defined a % eye opening inferior to 85% as an index of the development of oral-ocular synkinesis. There was a significant correlation between the values of ENoG 10-14 days after the onset of facial palsy and those of % eye opening 12 months later (ρ=0.81, $p<0.001$). The area under the ROC curve for the ENoG value was the predictor for the development of oral-ocular synkinesis at 0.913 (95%CI: 0.831-0.996, $p<.001$). The optimum cut-off value of ENoG

10-14 days after the onset of facial palsy was 46.5% to predict the development of oral-ocular synkinesis 12 months after the onset of facial palsy (sensitivity 97.1% and specificity 77.5%).

Conclusion

The value of ENoG 10-14 days after the onset of facial palsy is a predictive factor for the development of facial synkinesis 12 months later. Since facial palsy patients with a ENoG value inferior to 46.5% have a high risk of developing synkinesis, they should receive the facial biofeedback rehabilitation with a mirror as a preventive therapy.

Keywords: facial palsy; facial synkinesis; electroneurography; % eye-opening; predictive factor

Introduction

Facial synkinesis is one of the most unpleasant sequelae of facial palsy. Facial palsy patient with severe nerve injury often suffered from facial synkinesis, and once this sequela is established, facial nerve function hardly recovers completely [1,2,3]. Clinicians use electroneurography to evaluate the degree of facial nerve injury. It was reported that facial palsy patients with the ENoG value lower than 40% have the risk of developing facial synkinesis [2,3]. However, in those reports, facial synkinesis was only evaluated qualitatively using blink reflex or visual assessment of involuntary facial movements.

In the present study, we investigated whether the value of ENoG is a predictive factor for the development of facial synkinesis in patients with facial palsy. For this purpose, we used the % eye opening to evaluate the degree of oral-ocular synkinesis quantitatively [4]. We defined the % eye opening as the ratio of the interpalpebral distance on the affected side relative to that of the normal side. First, we examined the normal range of % eye opening in healthy volunteers. Then, we examined the relationship between ENoG value 10-14 days after the onset of facial palsy and the % eye opening 12 months later. Finally, we investigated the cut-off value of ENoG 10-14 days after the onset of facial palsy to predict the development of oral-ocular synkinesis sequela.

Materials and methods

Subjects

The present study includes 20 healthy volunteers without a history of facial palsy (12 men and 8 women; 25-65 years old; mean age: 42.3 ± 9.7 years) and 51 patients with facial palsy including 38 with Bell palsy and 15 with herpes zoster oticus (28 men and 25 women; 11-86 years old; mean age: 54 ± 19 years). We administered a corticosteroid to patients with Bell palsy, while a corticosteroid associated with an antiviral agent ~~was~~ were administrated to patients with herpes zoster oticus within 7 days of the onset of facial palsy. None of them received facial rehabilitation. This study was approved by the Committee for Medical Ethics of Tokushima University Hospital.

% eye opening

The degree of oral-ocular synkinesis was evaluated by an asymmetry of the interpalpebral space width during the mouth movement as previously reported [4] (Fig1). Accordingly, in the frontal view, patient's facial movements were recorded during the three designated mouth movements, lip pursing [u], teeth baring[i], and cheek puffing [pu], three times by video recorder (Sony TRV 900, Sony Corp, Tokyo). Patients were instructed to look at the lens of the recorder and to concentrate on the three designated mouth movements entirely to avoid any other voluntary facial movement of the eyelid and brow. Their facial images were uploaded to a hard disc drive of a computer using DV gate motion software (Sony) and still facial images during the 3 designated mouth movements were captured. A still facial image of each maximum mouth movements was then selected in each patient and processed using DV gate still software (Sony). After that, the interpalpebral space width was measured bilaterally from the still facial images on a monitor screen with Adobe Photoshop images (Adobe Systems, San Jose, California) by an independent otolaryngologist blinded to clinical data. Finally, the

percentage asymmetry of the eye opening width (% eye opening) was calculated as the ratio of the interpalpebral space width of the affected side compared to that of normal side. The lowest % eye opening of the three designated mouth movements 12 months after the onset of facial palsy was used as the degree of oral-ocular synkinesis in each patient.

Electroneurography

Electroneurography was performed 10-14 days after the onset of facial palsy. Rectangular 0.2msec impulses of 1000Hz with stepwise increases of a stimulating current from 35mA to 50mA were given by a bipolar stimulator placed on the skin over the stylomastoid foramen, and the maximal compound action potential was recorded through the surface electrodes placed on the skin in the nasolabial fold. The ratio of the peak to peak amplitude of the maximal compound action potential of the affected side was calculated as a value of ENoG and compared to that of the normal side.

Statistical analysis

Kolmogorov-Smirnov test, Spearman's rank correlation coefficient and Receiver operating characteristic (ROC) analysis were used for statistical analysis (SPSS 22.0 for Windows; SPSS Inc, Chicago, Illinois), and $p<0.05$ was considered significant.

Results

All values of the % eye opening during the three designated mouth movements were logarithmically transformed in twenty healthy volunteers. These values showed a normal

distribution (p=0.08), and their mean values and standard deviation were 1.995 ± 0.032 (left/right) and 1.996 ± 0.015 (right/left), respectively. The normal ranges of logarithmical transformed values of the % eye opening were 1.930-2.058 (left/right) and 1.941-2.053(right/left) as mean ± 1.96 SD. After the normal ranges were transformed exponentially, their values were 85.3-114.3% (left/right) and 87.3-113% (right/left), respectively. Based on these results, we defined % eye opening of less than 85% as an index of the development of oral-ocular synkinesis.

Among 51 patients with facial palsy, oral-ocular synkinesis developed in 34 patients, because their value of % eye opening was lower than 85% 12 months after the onset of facial palsy. There was a significant correlation between the values of ENoG 10-14 days after the onset of facial palsy and those of % eye opening 12 months after the onset of facial palsy ($r=0.81$, $p<0.001$) (Fig 2). The predictor of oral-ocular synkinesis was assessed using the receiver operating characteristic (ROC) curve, and the area under the ROC curve was 0.913 (95%CI: 0.831-0.996, p<.001) (Fig 3). The optimum cut-off value of EnoG 10-14 days after the onset of facial palsy, defined as the point on ROC curve closest to the (0, 1) point, was 46.5% to predict the development of oral-ocular synkinesis 12 months after the onset with a sensitivity of 97.1% and specificity of 77.5%.

Discussion

投稿時

In the present study, there was a significantly correlation between the values of ENoG 10-14 days after the onset of facial palsy and those of % eye opening 12 months after the onset in facial palsy patients. This finding indicated that the patients with lower value of ENoG in

the acute stage of facial palsy will more likely suffer from oral-ocular synkinesis in the chronic stage. Because the value of ENoG means the rate of non-injured facial nerve, the reduction of ENoG values indicates an increased injury of facial nerve [5]. It was hypothesized that during regeneration process of injured facial nerve, aberrant axonal sprouting grows toward to inappropriate facial muscle and misdirection of regenerated facial nerve innervating facial muscles other than those previously innervated leads to the development of synkinesis [6]. Because highly injured facial nerve induces an increased number of regenerated axon aberrantly [6,7], it is suggested that the values of ENoG in the acute stage correlates with the severity of synkinesis in the chronic stage in facial palsy patients.

The present finding further suggests that the value of ENoG 10-14 days after the onset of facial palsy is a predictive factor for the development of synkinesis. Indeed, an ENoG cut off value of 46.5% at the acute stage of facial palsy predicted the development of oral-ocular synkinesis in the chronic stage with high sensitivity. Treatment of facial synkinesis that once developed after facial palsy is ineffective. Recently, we developed facial biofeedback rehabilitation using a mirror and demonstrated that it was effective in preventing synkinesis after facial palsy [4]. Therefore, it is suggested that facial palsy patients with less than 46.5% of ENoG value 10-14 days after the onset of facial palsy should receive the facial biofeedback rehabilitation with a mirror as a preventive therapy.

Conclusion

The value of ENoG 10-14 days after the onset of facial palsy is a predictive factor for the development of facial synkinesis 12 months after the onset of facial palsy. Since facial palsy

patients with an ENoG value lower than 46.5% have a high risk of developing synkinesis, those patients should receive the mirror rehabilitation as a preventive therapy.

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Authorship

Takahiro Azuma, data collection, data analysis, drafting and revision of the manuscript; Katsuhiko Nakamura, conception, study design, data collection, data analysis, final approval; Mika Takahashi, data collection and analysis; Hitomi Miyoshi, % eye opening analysis; Naoki Toda, data collection and analysis; Hidetaka Iwasaki, data collection and analysis; Noriaki Takeda, conception, critical review, final approval.

Disclosure statement

The authors declare not having any financial support or relationship that may pose a conflict of interest.

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Figure legends

Figure 1

Evaluation of the degree of oral-ocular synkinesis. % eye opening is defined as the ratio of the interpalpebral distance on the affected side (B) relative to that of the normal side (A).

Figure 2

Relationship between the value of ENoG 10-14 days after the onset of facial palsy and % eye opening 12 months later. n=51, r=0.81, p<.001.

Figure 3

Receiver operating characteristic (ROC) curve for the value of ENoG as the predictor of development of oral-ocular synkinesis. The area under the ROC curve was 0.913. The cut off value was determined at the point on ROC curve closest to the (0, 1) point. The cut off value of ENoG was 46.5% to predict the development of oral-ocular synkinesis with a sensitivity of 97.1% and a specificity of 77.5%.

Fig1

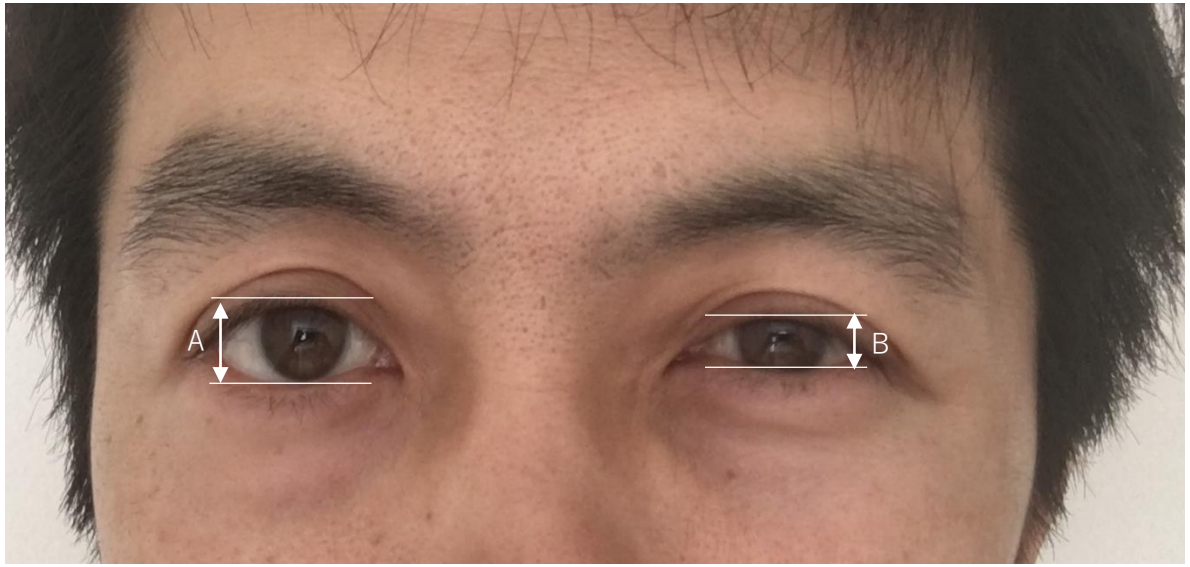

Fig2

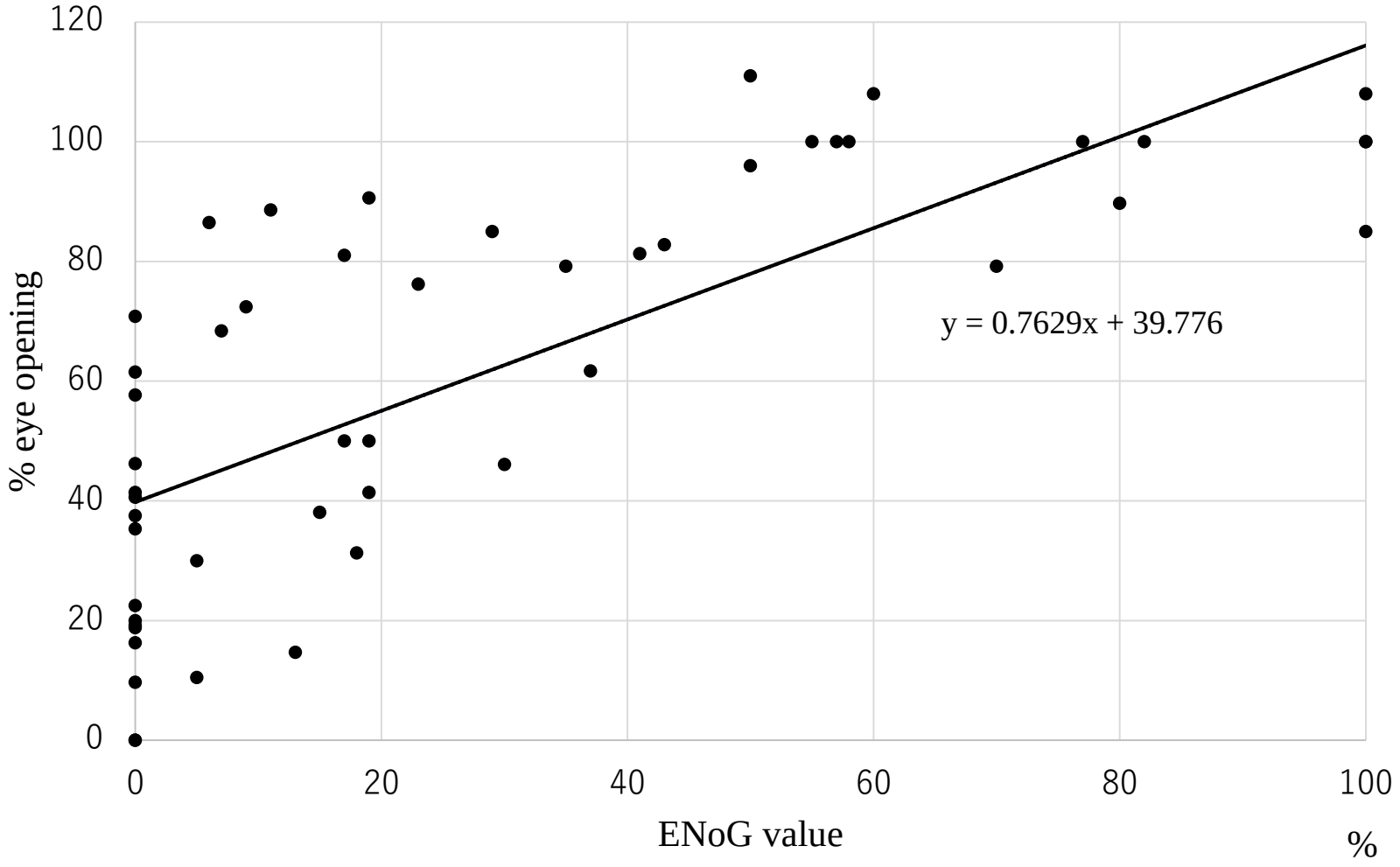
120
100
80
60
40
20
0
% eye opening
y = 0.7629x + 39.776
0
20
40
60
80
100
ENoG value
%

Fig3